Ligna-Sweep

MODEL CP

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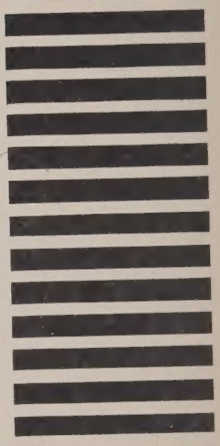

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OPERATING
AND MAINTENANCE MANUAL

ISSUE A

Ligna-Sweep

MODEL CP

SWEEPING OSCILLATOR

QC CAL/CERT
PROCEDURES
GROUP COPY

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TABLE OF CONTENTS

Paragraph *Page*

SECTION I, FUNCTION AND DESCRIPTION

1-1 Introduction 1
1-2 Features 1
1-3 Specifications, Model B 2
1-4 Specifications, Model A 2
1-5 Tube Complement 2
1-6 Equipment Supplied 2

SECTION II, INSTALLATION

2-1 General Instructions 3
2-2 Interconnection Data 3

SECTION III, FUNCTION OF CONTROLS AND TERMINALS

3-1 Front-of-Panel Controls 4
3-2 Front-of-Panel Terminals 6
3-3 Internal Controls 7

SECTION IV, OPERATION

4-1 General Discussion 8
4-2 Sweeping Oscillator Operation 8
4-3 CW Operation 8

SECTION V, CIRCUIT DESCRIPTION

5-1 Introduction 9
5-2 General Discussion 9
5-3 Circuit Analysis 11
5-3A Sweep Generator (V-1) 11
5-3B Sawtooth Amplifier (V-2) 15
5-3C Balanced Modulators and Crystal-Controlled Oscillators 16
5-3D Trigger Amplifier and Pip Generator Circuits 17
5-3E Automatic Gain Control Circuits 18
5-3F Regulated Power Supply Circuits 18

SECTION VI, MAINTENANCE

6-1 Trouble-Shooting 20
6-2 Voltage Measurements 21
6-3 Resistance Measurements 22
6-4 Alignment and Adjustment 22
6-5 Reshipment Instructions 27

SECTION VII, PARTS LISTS

7-1 Parts List for Ligna-Sweep Model CP 28
7-2 Parts List for Power Supply Section 34

ILLUSTRATIONS AND TABLES

Figure		*Page*
1-1	Ligna-Sweep Model CP ..... Facing	1
2-1	Equipment Interconnections	3
5-1	Functional Block Diagram	10
5-2	Sweep Generator, Simplified Circuit	12
5-3	Top View, Ligna-Sweep Model CP	13
5-4	Bottom View, Ligna-Sweep Model CP	14
5-5	Sweep Amplifier (V-2), Simplified Circuit	15
6-1	External Detector Circuit	23
6-2	Voltage Measurements, Ligna-Sweep	21
6-3	Resistance Measurements, Ligna-Sweep	22
6-4	Voltage Measurements, Power Supply Section	27
6-5	Resistance Measurements, Power Supply Section	27
7-1	Schematic #KD-5072-E 29,	30
7-1A	Schematic #KD-5072-F 35,	36

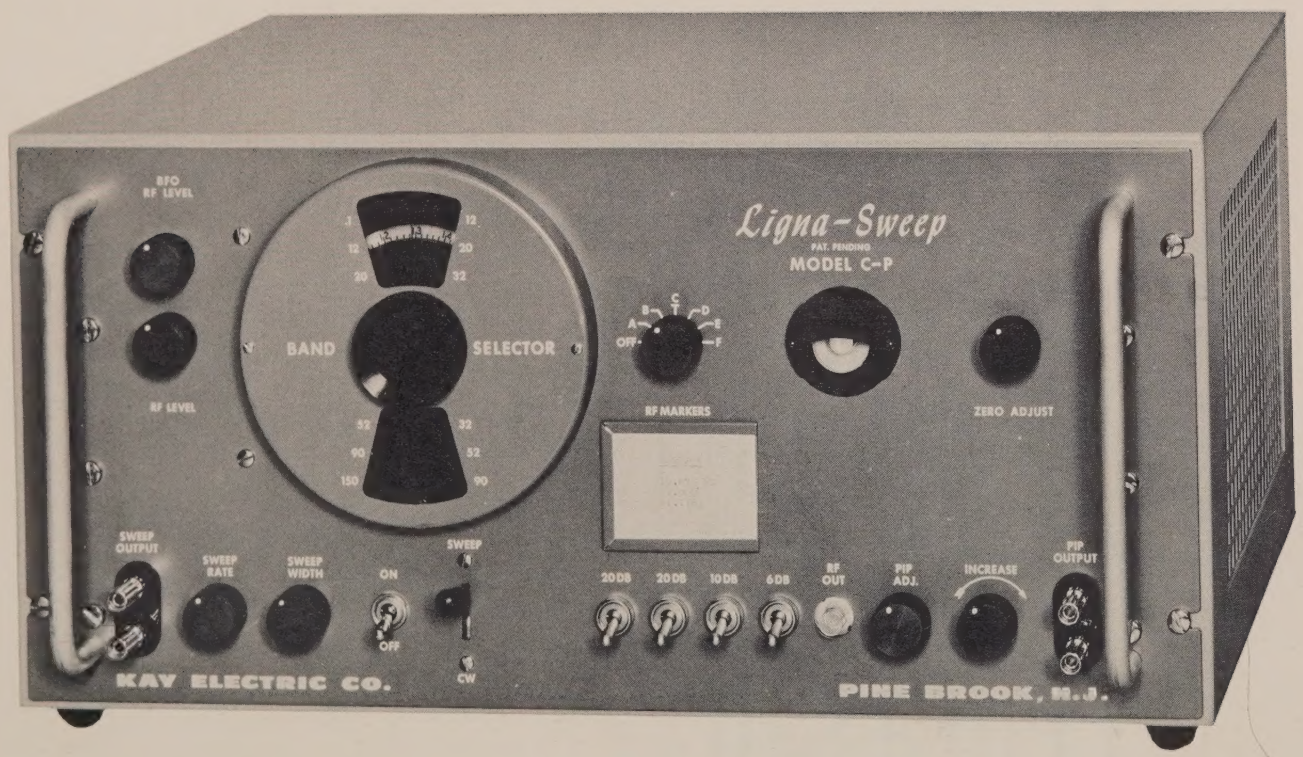


Figure I-1, LIGNA-SWEEP MODEL CP

SECTION I
FUNCTION AND DESCRIPTION

1-1 INTRODUCTION.

The LIGNA-SWEEP MODEL CP is an all-electronic, wide-range, sweeping oscillator, with variable center frequencies and sweep width. Two versions are available, Catalog #932-A and 932-B. These instruments are similar except for swept frequency range. (See Specifications). Both instruments can also be operated as CW generators.

When operating as a sweeping oscillator, center frequencies between 100 kc and 150 mc are available (or 100 kc to 215 mc, depending on whether the A or B version of the instrument is used). When operated as a CW generator, the instrument is continuously tunable across this frequency range. Up to 18 crystal-controlled, pulse-type markers are available at frequencies specified by the customer. Markers can be switched singularly or in groups of two or more, to define bandpass, picture and sound carrier frequencies, etc., in accordance with the customers' specific requirements.

An electronically regulated power supply and fast-acting agc circuits insure stable output for all modes of operation. The high-level output voltage of both the swept rf and cw, is adequate for testing most circuits without additional amplification, thus eliminating errors usually introduced by the additional amplification. A precision attenuator is incorporated ahead of the rf output terminal providing accurate amplitude calibration of the scope display.

Advanced engineering techniques and the inherent quality of the LIGNA-SWEEP make it a truly reliable instrument for laboratory or production line use.

1-2 FEATURES.

Variable permeability techniques are used in an all-electronic circuit, to generate flat sweeps with center frequencies and sweep widths variable. The sweeping oscillator covers the frequency range in six, switched, overlapping bands and output frequency is read directly on an illuminated, individually calibrated dial. Since the sweeping oscillator is synchronized with a sawtooth sweep; used for horizontal deflection of the scope, the swept frequency is proportional to the sawtooth making phasing controls unnecessary. The selected frequency range is repetitively swept at a nominal 60-cps rate which, in conjunction with scope screen persistence, produces flicker-free scope displays. The sweep generator can be locked to line frequency, or varied about this frequency to detect hum.

Two crystal-controlled oscillators and associated balanced modulators, are incorporated to produce low-order frequencies for energizing the marker crystals used on the first band position. Marker crystals for the remaining bands are energized directly by the swept rf as it passes the characteristic frequency of the crystals in the circuit. Thus, individual, or grouped trigger pulses are produced at specified frequencies for each band. A panel switch permits selection of appropriate trigger pulses. The final crystal-controlled, pulse-type markers can be varied in amplitude from zero to at least 10 volts peak.

All controls and terminals required for normal operation of the LIGNA-SWEEP are conveniently located on the front panel. The electronically regulated power supply, fast-acting agc and carefully engineered shielding, rf filtering, and rugged mechanical construction, insure highly accurate performance.

1-3 SPECIFICATIONS, MODEL B

Frequency Ranges:

Band A - 100 kc to 12 mc beat-frequency output.
Sweep Width - continuously variable between 100 kc - 12 mc.

Band B - 12 to 20 mc fundamental freq. output.
Sweep Width - continuously variable to 60% of center frequency.

Band C - 20 to 32 mc fundamental freq. output.
Sweep Width - continuously variable to 60% of center frequency.

Band D - 32 to 52 mc fundamental freq. output.
Sweep Width - continuously variable at least 15 mc.

Band E - 52 to 90 mc fundamental freq. output.
Sweep Width - continuously variable to at least 20 mc.

Band F - 90 to 150 mc fundamental freq. output.
Sweep Width - continuously variable to at least 20 mc.

RF Output:

Band A - (0.1 - 12 mc) 0.25V rms into nominal 70 ohms.

Band B, C, D, E & F - (12 - 150 mc) 1.0V rms into nominal 70 ohms. (50-ohm termination on request).

Flatness: Flat within ±0.5 db over widest sweep.

Sweep Rate: Variable around 60 cps; locks to line frequency.

Attenuators: Individually switched, 20 db, 20 db, 10 db, 6 db, plus continuously variable 6 db increment.

Markers: Up to 18 sharp, crystal-controlled, pulse-type markers, at customer specified frequencies (within the frequency range of the instrument). Selectable by separate panel control.

Marker Amplitude: Positive pulse, continuously variable; zero to 10 volts peak (approx.).

Sweep Output: Regular sawtooth, synchronized with sweeping oscillator; amplitude 7.0V (approx.).

Power Supply: Input approx. 100 watts, 117-V (±10%), 50-60 cps. B^+ electronically regulated.

1-4 SPECIFICATIONS, MODEL A

Frequency Ranges:

Band A - Same as Model B.

Band B - 20 to 30 mc fundamental freq. output.
Sweep Width - Continuously variable to 60% of center frequency.

Band C - 35 to 55 mc fundamental freq. output.
Sweep Width - continuously variable to 60% of center frequency.

Band D - 55 to 85 mc fundamental freq. output.
Sweep Width - continuously variable to at least 20 mc.

Band E - 85 to 135 mc fundamental freq. output.
Sweep Width - continuously variable to at least 20 mc.

Band F - 135 to 215 mc fundamental freq. output.
Sweep Width - continuously variable to at least 20 mc.

Physical Data

Dimensions: Std. 19½" rack panel; 8¾" x 12½".

Weight: 30 lbs.

1-5 TUBE COMPLEMENT.

Type	Qty.	Type	Qty.	Type	Qty.
6J6	1	6E5	1	6AG5	1
6V6	1	5U4GB	1	OB2	1
5718	2	12AU7	3	6AU6	2
6BK7	3	6AQ5	2	12AT7	1

1-6 EQUIPMENT SUPPLIED.

Ligna-Sweep Model CP
Marker Crystals as specified
Instruction Manual

SECTION II
INSTALLATION

2-1 GENERAL INSTRUCTIONS.

The LIGNA-SWEEP is designed for either tabletop or rack mounting and presents no special installation problems. However, to insure optimum performance, the equipment should not be subjected to unusual environmental conditions, such as excessive moisture, vibration or extreme temperatures. The installation should include provision for connection to an oscilloscope, to the circuit under test and to a 100-watt power source of 117-V (±10%), 50-60 cps.

2-2 INTERCONNECTION DATA.

Step 1 – LIGNA-SWEEP MODEL CP is designed to work into a nominal 70 ohms. If the input impedance of the circuit under test is other than 70 ohms, an impedance matching network may be necessary and should be inserted between the sweeping output of the LIGNA-SWEEP and the circuit under test. It is also recommended that coaxial cable be used to make connections between the test equipment. Fig. 2-1.

Step 2 – Oscilloscope Connections - Connect a length of coaxial cable between the SWEEP OUTPUT terminals on the LIGNA-SWEEP and the horizontal input terminals of the scope.

Step 3 – Connect the RF OUTPUT to the input of the circuit under test and the output of the test circuit to the vertical input terminals of the scope.

Step 4 – If the bandpass of the scope is less than that of the circuit being tested, insert a detector circuit between the scope and the circuit being tested. Fig. 2-1.

Step 5 – The PIP OUTPUT is also connected to the vertical input of the scope to furnish positive-going frequency markers on the scope trace.

Step 6 – If the markers alter the shape of the scope pattern, insert a 47K, ½ watt resistor in series with the marker signal lead, directly at the scope Y-input terminals. Fig. 2-1.

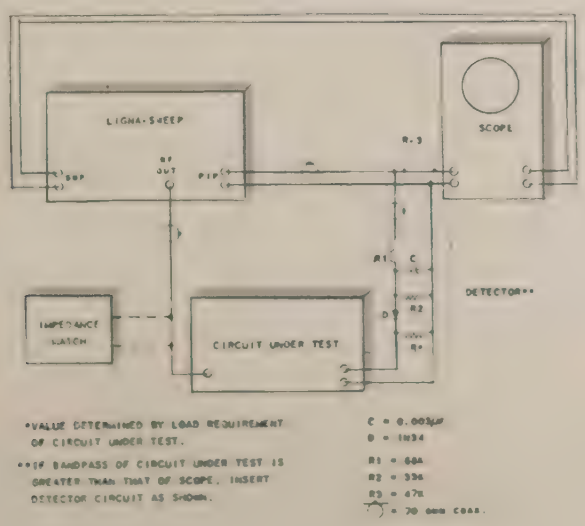


Figure 2-1, Equipment Interconnections.

SECTION III
FUNCTION OF CONTROLS AND TERMINALS

3-1 FRONT-OF-PANEL CONTROLS.

Control	Position	Function
Power ON-OFF Switch (S-1)	ON	This toggle-type switch, located below the band switching dial, controls ac power input to the instrument. When this switch is in the ON position transformers T-1 and T-2 are energized, furnishing filament voltage to all tubes, and B+ to the activated circuits; depending on the setting of the CW-SWP switch S-3 and BAND SELECTOR switch S-2.
	OFF	When S-1 is in OFF position the equipment is completely de-energized.
BAND SELECTOR Switch (S-2)	6 positions; Bands A thru F	This large rotary-type switch is used to select any one of six frequency bands covering the calibrated frequency spectrum. The BAND SELECTOR switch can be rotated both clockwise and counterclockwise until the selected band calibration is visible through the illuminated dial window.
SWEEP-CW Switch (S-3)	SWEEP	This lever-type switch, located to the right of the ON-OFF switch, is used to select the type of rf made available at the RF OUTPUT jack J-2. When set for SWEEP, the instrument operates as a sweeping oscillator.
	CW	In CW position, a steady cw signal is generated and made available at RF OUTPUT jack J-2.
RF MARKER Switch (S-4)	Up to 6 positions	This rotary switch permits selection of pip-type frequency markers (at frequencies specified by the customer). The RF MARKER switch is located between the BAND SELECTOR switch and the zero indicator V-5.
Attenuator Switches (S-3 thru S-8)	Stepped	These are toggle switches located below the RF MARKER switch and permit insertion of attenuation in fixed steps of 20, 20, 10 and 6 db ahead of the RF OUTPUT jack J-2. The RF LEVEL control R-66A furnishes an additional 6-db increment of variable attenuation.

Control	Position	Function
Frequency Control (C-15A & C-15B)	Variable	The center concentric knob of the BAND SELECTOR controls a dual section variable capacitor, providing plate tuning of the rf oscillators V-3, V-13. In cw operation, this frequency will be that appearing at the RF OUTPUT jack J-2; in sweeping oscillator applications, it will be the center frequency of the sweeping rf output.
SWEEP RATE Control (R-2)	Variable	The SWEEP RATE control provides a means of varying the frequency of the sweep generator V-1, when S-3, the SWEEP-CW switch is in SWEEP position. The sweep rate can be adjusted about the nominal 60-cps for hum measurements and other special tests.
SWEEP WIDTH Control (R-21)	Variable	This control, located to the right of the SWEEP RATE control, permits adjustment of the sweep width by changing the amplitude of the sawtooth current through the sweep yoke L-1.
BFO RF LEVEL Control (R-121)	Variable	This control is located in the upper left corner of the panel, above the RF LEVEL control. The amplitude of rf output- on the 0.1 to 12 mc band- can be adjusted with this control by varying the B^+ voltage applied to the 30-mc crystal oscillator V-4.
RF LEVEL Control (R-66A & R-66B)	Variable	Section A of this dual control provides adjustment of grid bias on the 1st agc amplifier and eventually the amplitude of sweeping oscillator output. Section B simultaneously controls the amplitude of the trigger at the grid of the 2nd trigger amplifier V-10 as the RF LEVEL control is varied.
PIP ADJ Control (R-104)	Variable	This control is located between the RF OUT terminal and the INCREASE control. It provides a means of adjusting the amplitude of the trigger at the grid of the 2nd trigger amplifier V-10 (when the RF LEVEL control must remain at a given position to maintain rf output at J-2 to a pre-selected level).

Control	Position	Function
INCREASE Control (R-119)	Variable	This control provides a means of varying the amplitude of the PIP OUTPUT at J-3.
ZERO ADJUST Control (R-17)	Variable	This control permits adjustment of the amplitude of current flow through V-2 and the sweep yoke; thus affording limited adjustment of the cw frequency for calibration of the 100 kc - 12 mc range. With the BAND SELECTOR switch set to the lowest band, the SWEEP-CW switch set at CW, and the frequency dial tuned to zero, the ZERO ADJUST control should be set for maximum opening of the tuning eye indicator V-5.

3-2 FRONT-OF-PANEL TERMINALS.

Terminal	Function
SWEEP OUTPUT (J-1)	These are GR-type binding-post terminals located in the lower left corner of the panel. The sawtooth voltage, synchronized with the rf output, is used as a horizontal deflection voltage for the scope.
RF OUT (J-2)	This is a BNC-type terminal located between the 6 DB attenuator switch and the PIP ADJ control. Either cw or swept rf is available from this terminal. The output is normally connected directly to the input of the circuit under test.
PIP OUTPUT (J-3)	These are also GR-type binding-post terminals from which the marker pips are available. During sweeping oscillator operation, and depending on the setting of the BAND SELECTOR switch, the pips will be frequency spaced on the swept band; when the equipment is interconnected as shown in Fig. 2-1.

3-3 INTERNAL CONTROLS.

Control	Position	Function
B+ Adj. Pot (R-212)	Variable	This control is located on the rear flange of the chassis and should be adjusted to provide 250V B+ at the junction of C-201B and R-211.
Lin. Adj. Pot (R-22)	Variable	This control is located on the left side flange of the chassis and is used only in sweeping oscillator operation. It is adjusted until the rate of frequency change is linear across the entire sweep width.
Pip Adj. Pot (R-116)	Variable	This control is located on the right side flange of the chassis and controls the firing point of V-11, the pip generator.

Note: Adjustment of internal controls, other than the above is covered in Section 6-4 dealing with alignment and adjustment. Adjustment of internal controls other than the above should not be undertaken except when recalibration of the equipment is contemplated.

SECTION IV
OPERATION

4-1 GENERAL DISCUSSION.

This section contains general instructions for operating the LIGNA-SWEEP, however, detailed instructions for making input and output connections to the circuit under test are not included. Such instructions would require specific reference to the numerous types of TV receivers, TV tuners, IF amplifiers, etc., in use. Specific information on this subject is available from the many books and references devoted to the subject.

It is assumed the LIGNA-SWEEP and associated equipment have been interconnected as outlined in Section 2-2, and as illustrated in Fig. 2-1. Incorporation of the impedance matching device and external detector in the test set-up will depend on the requirements of the circuit being tested, and the bandwidth of the scope. It is important that the interconnecting cables and terminating connectors provide a proper impedance match at the equipment input and output terminals. All leads should be as short as possible consistant with placement of equipment on the bench or in the test rack.

4-2 SWEEPING OSCILLATOR OPERATION.

Turn on the LIGNA-SWEEP and scope, and allow a fifteen-minute warm-up. If the circuit under test includes electron tubes, it should also be warmed up to stabilize the circuit.

Step 1 - For sweeping oscillator application, set the SWP-CW switch S-3 to SWP position. Set the BAND SELECTOR switch to the desired frequency range and adjust Frequency control C-15 to the appropriate center frequency.

Step 2 - Adjust the scope controls for an on-screen pattern. Since the sweep voltage for horizontal deflection of the scope is supplied by the LIGNA-SWEEP, the scope sweep generator is not used. Set scope X-axis controls for X-amplifier operation.

Step 3 - Adjust SWEEP RATE control R-2 for stable scope trace (sawtooth generator locked to line frequency). When the sweep rate is other than 60 cps, the trace will waver horizontally.

Step 4 - Adjust RF LEVEL control R-66 and scope Y-gain controls for desired vertical amplitude of trace. Stepped attenuation can be inserted, if required, by switching in 20, 20, 10 or 6 db attenuation by actuating switches S-5 thru S-8. Horizontal amplitude is controlled by the scope X-gain control and X-axis input attenuator. On the first band position, rf output amplitude is adjusted by the BFO LEVEL control R-121.

Step 5 - For frequency markers, set the RF MARKER switch S-4 to the appropriate position to furnish markers within the frequency range of band position being used. Vary the PIP ADJ control R-104 until pip generator V-11 fires (indicated by marker pips appearing on the scope trace). Then adjust INCREASE control R-119 for desired marker amplitude. If the markers seriously alter the scope pattern, insert a 47K resistor (R-3 in Fig. 2-1) in series with the pip output lead directly at the scope Y-input terminal, or directly at the PIP OUTPUT terminal J-3.

4-3 CW OPERATION.

Step 1 - Set SWEEP-CW switch S-3 to CW position.

Step 2 - When operating on the 1st band position, set Frequency control C-15 to zero-frequency and vary ZERO ADJ control R-17 for maximum opening of the tuning eye indicator V-5. This procedure calibrates the zero-frequency point on the dial by zeroing the 30-mc oscillator frequency (V-4) with the 30-mc point of the sweeping oscillator (V-3, V-13).

Step 3 - Band switching and frequency tuning for cw operation are accomplished the same as for sweeping oscillator operation. Amplitude of the cw output is controlled by the RF LEVEL control (except for the low frequency band where it is controlled by R-121, the BFO LEVEL). The sweep generator and pip generating circuits do not function during cw operation. Attenuation can be inserted as in sweeping oscillator operation.

SECTION V
CIRCUIT DESCRIPTION

5-1 INTRODUCTION.

This section contains a general discussion of the LIGNA-SWEEP circuits and detailed analysis of those circuits requiring such treatment. While a working knowledge of the circuitry is not essential to operate the instrument, this information is useful to the service technician and discriminating user desiring to exploit the instruments' versatility to the fullest extent. The functional block diagram (Fig. 5-1) illustrates the relationship of the instruments' major circuits.

Major Circuits Described:

A. Sawtooth Sweep Circuits.

B. RF Circuits.

C. AGC Circuits.

D. Trigger Amplifier & Pip Generator Circuit.

E. Power Supply.

5-2 GENERAL DISCUSSION.

A. Sawtooth Sweep Circuits.

These circuits generate a sawtooth voltage, used to frequency modulate the rf oscillator when it is being used as a sweeping oscillator, and as a horizontal deflection voltage for the scope. The sawtooth frequency can be varied about the nominal 60-cps line-frequency for hum measurements and sweeping through high-Q circuits by adjusting R-2.

The sweep generator circuit uses a type 6J6 (V-1) in a multivibrator circuit to generate a train of square-waves which are shaped to a regular sawtooth in an integrating network consisting of R-10, R-11 and C-6, C-7. The resultant saw-signal is available at the SWEEP OUTPUT terminals J-1. The square-wave is also used as a blanking signal for the rf oscillators (V-3, V-13) during the retrace period; providing a zero-level reference line on the scope screen. A portion of the square-wave signal generated by V-1 is also passed through a differentiating network (C-2, R-1) to the grid of V-6, to blank the 1st agc amplifier; thus preventing the rf oscillator plate voltage from rising when the output is cut off during retrace time.

A type 6V6 (V-2) is used as a pentode amplifier for the shaped sawtooth signal. Plate potential for V-2 is fed through the control winding (L-1) of the sweep yoke. During sweeping oscillator operation, the plate current of V-2 varies with the sawtooth voltage on its grid, causing a corresponding variation in the inductance of the sweep yoke secondaries L-2A, L-3A, etc. Since the individual secondaries are the tank coils for the sweeping oscillators (V-3, V-13) the output frequency varies with the instantaneous inductance of the tank coil. SWEEP WIDTH pot R-21 controls the amplitude of the sawtooth voltage applied to the grid of V-2 and thus, the width of the sweeping output of V-3, V-13. When the SWEEP-CW switch is set for CW operation, sweep generator V-1 is disabled by removing B^+ from its plates. The sawtooth amplifier V-2 then acts as a constant-current tube with a steady dc current flow passing from B^+ through L-1 and V-2. Since sweep generator V-1 is disabled, the blanking signal is also removed from the oscillators during cw operation.

B. RF Circuits.

Sweeping oscillators V-3, V-13 are type 5718 sub-miniature triodes used in a balanced, plate-coupled, push-pull oscillator circuit to generate a sweeping output. Center-frequency is determined by the setting of BAND SELECTOR switch S-2 and tuning capacitor C-15A, C-15B. The swept frequency at any given time is determined by the permeability of the ferrite in the sweep yoke secondary that is in the circuit, at the time, and by the magnitude of sawtooth amplifier plate current flowing through the primary winding. The sweeping output is coupled from the plate circuit through pick-off loops L-2B, L-3B, etc. The output is then fed either to a balanced modulator, or to the crystal marker circuits, and the RF OUTPUT (depending on the setting of S-2). A separate transformer (T-2) furnishes filament voltage for the sweeping oscillators V-3, V-13. RF is filtered from the filament circuit by L-11, L-12 and

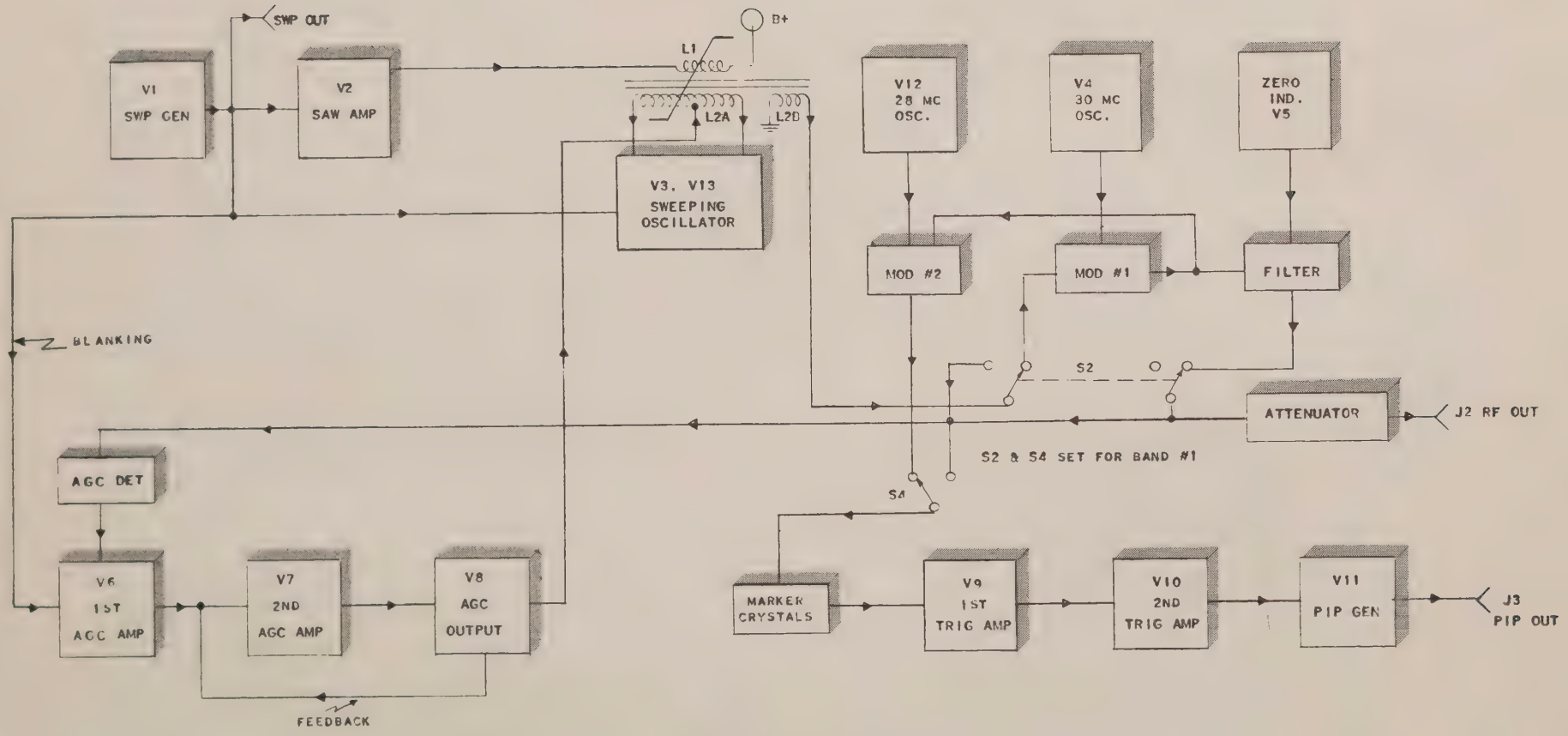


Figure 5-1, Functional Block Diagram, KB-6701-A

C-44, C-46. Two crystal-controlled high-frequency oscillators V-12, V-4 are used in conjunction with two balanced modulators, to produce the frequency sweeps and activate the marker crystals on the low band setting. A type 6E5 tuning-eye (V-5) is used as a ZERO INDICATOR in conjunction with the ZERO ADJ control, to calibrate the cw output on the 100 kc - 12 mc range. The remaining five band positions make use of the sweeping oscillator output directly for frequency sweeps and to resonate the marker crystals.

C. Automatic Gain Control Circuits.

A sample of the rf output signal is fed to a voltage-doubler detector circuit. The resultant rectified negative voltage is applied to the input grid of the 1st agc amplifier as an error voltage. Thus, an increase in amplitude of the rf output presents a higher negative voltage at the grid of V-6; or conversely, a decrease of rf output lowers the negative voltage (grid bias) at the agc input stage. The circuit constitutes a negative feedback loop providing stable oscillator output.

After amplification, the error voltage is applied to the grids of V-8, the cathode-follower output stage. V-8 is in series with B+, the sweep yoke secondaries L-2A, L-3A, etc., and the plates of the sweeping oscillators V-3, V-13. V-8 thus supplies the plate voltage for the oscillator tubes.

D. Trigger Amplifier & Pip Generator Circuits.

These circuits generate pulse-type, crystal-controlled markers at fixed frequencies, through a series of selectable, tuned absorption-type crystal filters. Each crystal, as it is switched into the circuit, will resonate as the swept frequency passes the crystal frequency. Since the crystals can be switched into the circuit in groups, one or more resonances can be generated for each swept band. The resonances are detected amplified and then fed to the pip generator V-11 as trigger pulses.

V-11 functions as a one-shot multivibrator, triggered by the pulses received from the 2nd trigger amplifier V-10. Each trigger pulse causes the pip generator to produce one positive marker pulse. The output is coupled from the cathode of V-11 through the INCREASE control R-119 to the PIP OUTPUT terminal J-3.

E. Power Supply Section.

Voltage regulator circuits are incorporated in the power supply to compensate for power-line voltage fluctuations, or changes in the power-supply load. The regulator circuit senses these changes and responds by producing an opposite voltage to maintain the output constant.

Power transformer T-1 furnishes filament voltage for all tubes except the sweeping oscillator tubes (the filament voltage for these tubes is supplied by transformer T-2). The high voltage produced in the secondary winding of T-1 is applied to V-201, which is used in a full-wave rectifier circuit. The rectified output is then filtered and passed to the voltage regulator circuits. Regulated B+ potentials of 105 and 250 volts are available, plus 420 volts of unregulated B+.

5-3 CIRCUIT ANALYSIS.

While the foregoing general discussion of circuitry used in the LIGNA-SWEEP is adequate for operation of the instrument, a more detailed analysis may be helpful to service technicians and others desiring such information. The several circuits mentioned in the general discussion are analyzed in detail in this section.

5-3A SWEEP GENERATOR (V-1).

This is a plate-coupled, astable multivibrator, generating a train of square-waves at line-frequency, and variable about this frequency by adjustment of the SWEEP RATE control R-2. The setting of R-2 establishes the average dc bias for both grids, while the applied sine-wave at grid B serves to synchronize the multivibrator to the line.

Operation of the sweep generator can be analyzed by initially considering section B of the 6J6 as being at cutoff and section A conducting. Fig. 5-2. In this condition, the plate of section

B is at B+ potential and the plate of section A is at a low positive potential. Now consider a disturbance in the circuit causing section B to start conducting; its plate voltage will start to drop and being coupled through C-3 to the grid in section A, current through this section will be decreased. The resultant rise of plate potential in section A is coupled through C-4 to the grid in section B. The rising voltage on the grid of section B produces increased conduction and a further decrease in its plate voltage. This action continues until section B is fully conducting and section A is cut off. The multivibrator remains in this quasi-stable state until the negative charge on capacitor C-3 (which is holding section A at cutoff) leaks off through R-4. Then section A starts conducting and the cycle repeats.

The square-wave output is taken from plate B and is positive when section B is in cutoff, negative when B is conducting. The square-wave output is integrated by an R-C network consisting of R-10, R-11, C-6 and C-7 into a sawtooth signal which is brought out to the SWEEP OUT jack on the panel. This signal is also used to drive V-2, the sawtooth amplifier.

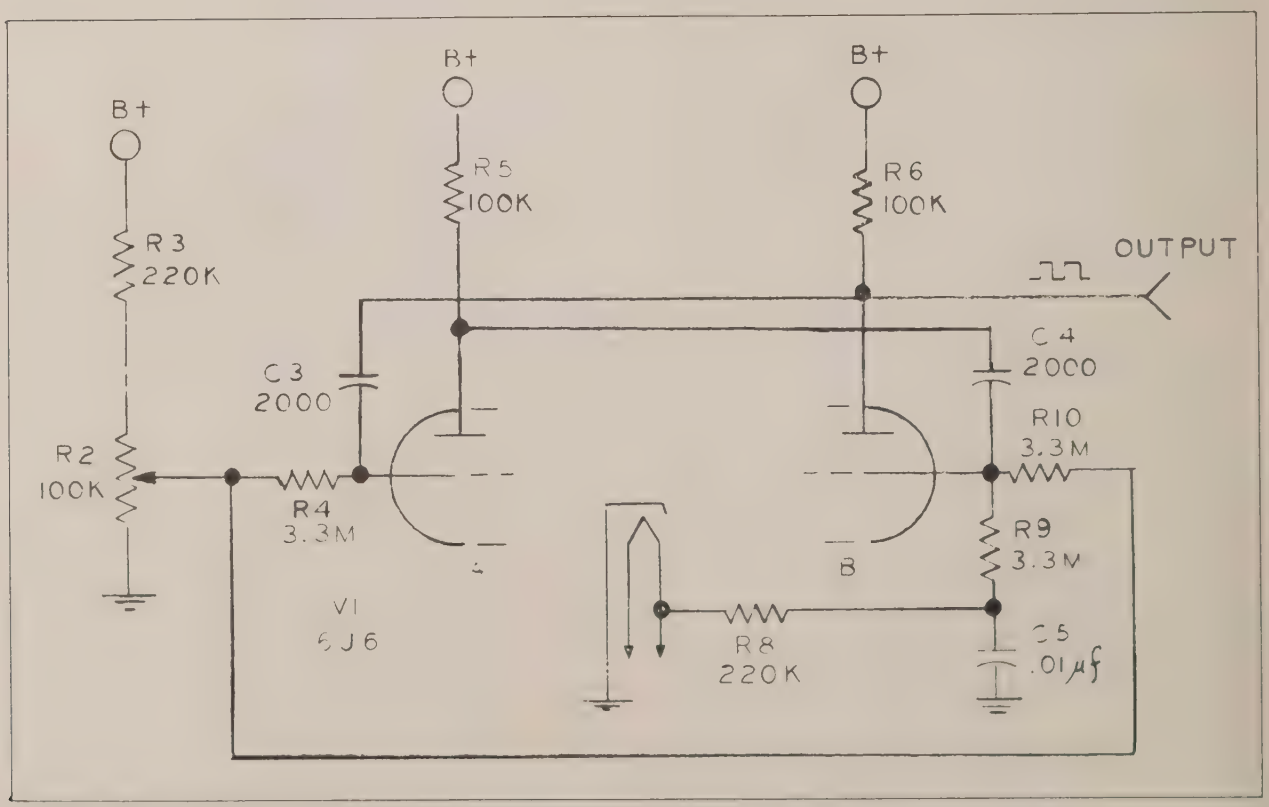


Figure 5-2, Sweep Generator V-1, Simplified Circuit

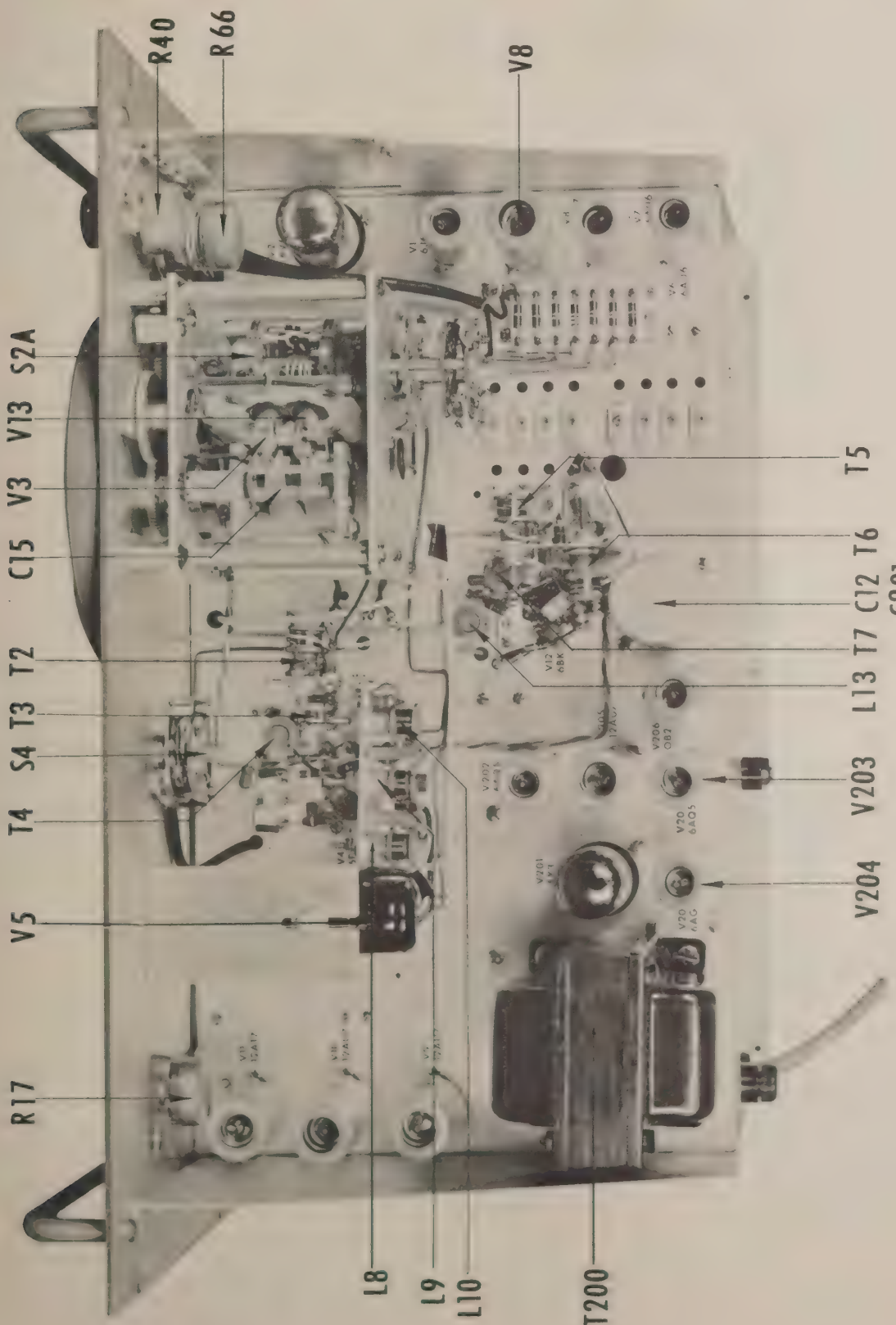


Figure 5-3, Top View, Ligna-Sweep Model CP

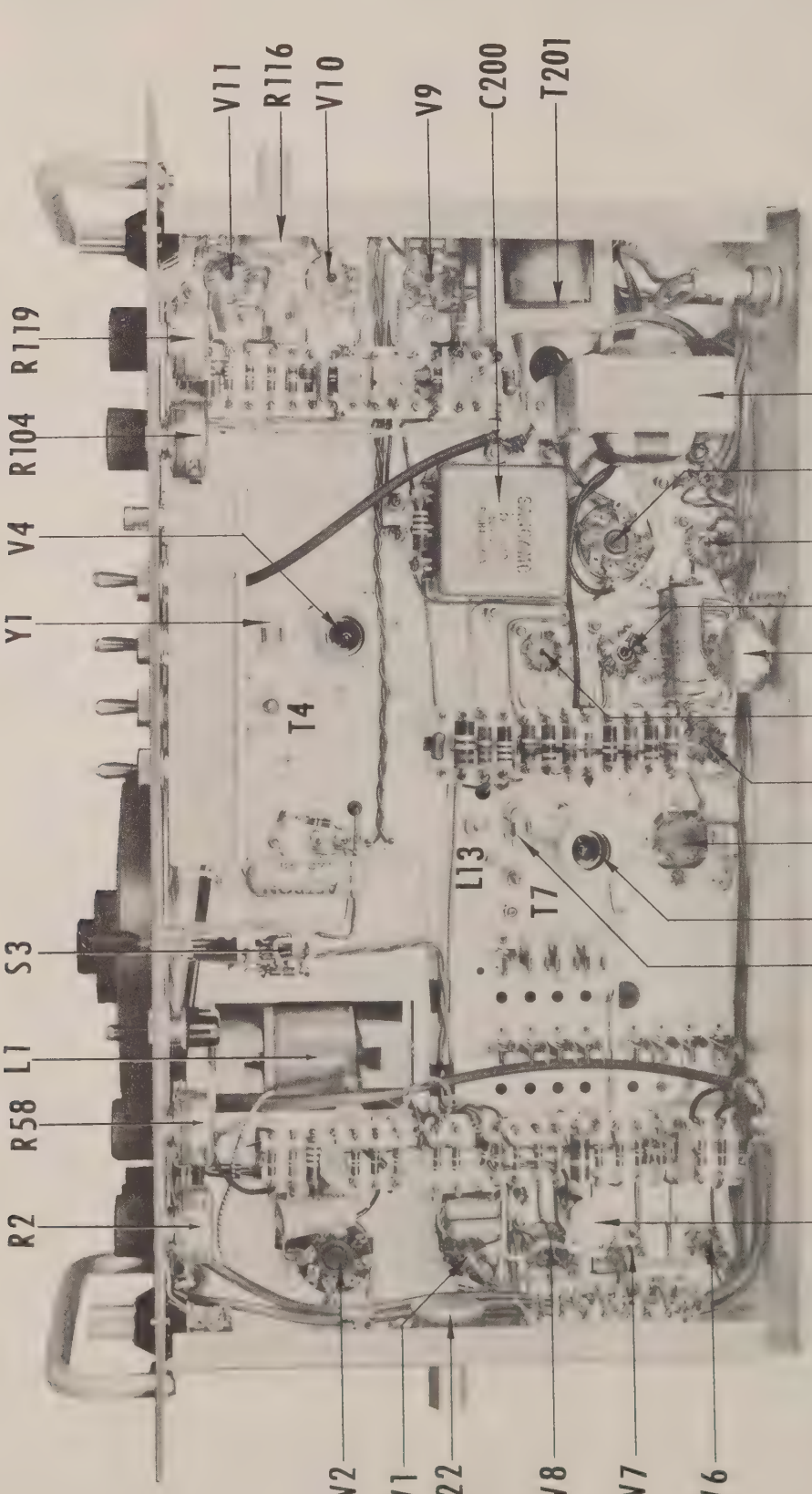


Figure 5-4, Bottom View, Ligna-Sweep Model CP

5-3B SAWTOOTH AMPLIFIER (V-2).

A type 6V6 pentode (V-2) amplifies the sawtooth signal and frequency modulates the rf oscillators V-3 and V-13. V-2 also acts as a constant-current tube during cw operation. When SWEEP-CW switch S-3 is set for CW operation, the control grid of V-2 is grounded and a steady dc current flows from B+ through the control winding L-1 of the sweep yoke and V-2. When S-3 is set for SWEEP operation, the control grid of V-2 receives the sawtooth signal coupled through C-8 from the sweep generator V-1 and amplifies it. The resultant sawtooth current flowing in the sweep yoke control winding L-1, varies the inductance of the secondary winding and the frequency of the rf oscillator output.

V-2 would function as a linear amplifier, except for the action injected in the cathode circuit by diodes D-2, D-3, and D-4. However, before further consideration is given to the diodes, operation of the sweep yoke should be explained.

The sweep yoke is an electromagnetic control device, which frequency modulates the rf oscillator by changing the inductance of the oscillator's plate-circuit tank coils. The sweep yoke consists of a control winding wound on a "C" shaped laminated iron core which straddles or "yokes" the turret holding the rf oscillator tank coils. The rf oscillator tank coils are wound on ferrite rods. The mechanical arrangement of yoke and turret is such that at each band position a ferrite rod "sits" in the open-side of the "C" yoke and completes its magnetic circuit.

Current through the control winding produces a magnetic field in the laminated core and the ferrite rod. The magnetic field through the ferrite reduces its permeability and therefore, the inductance of the coil wound on it (inductance

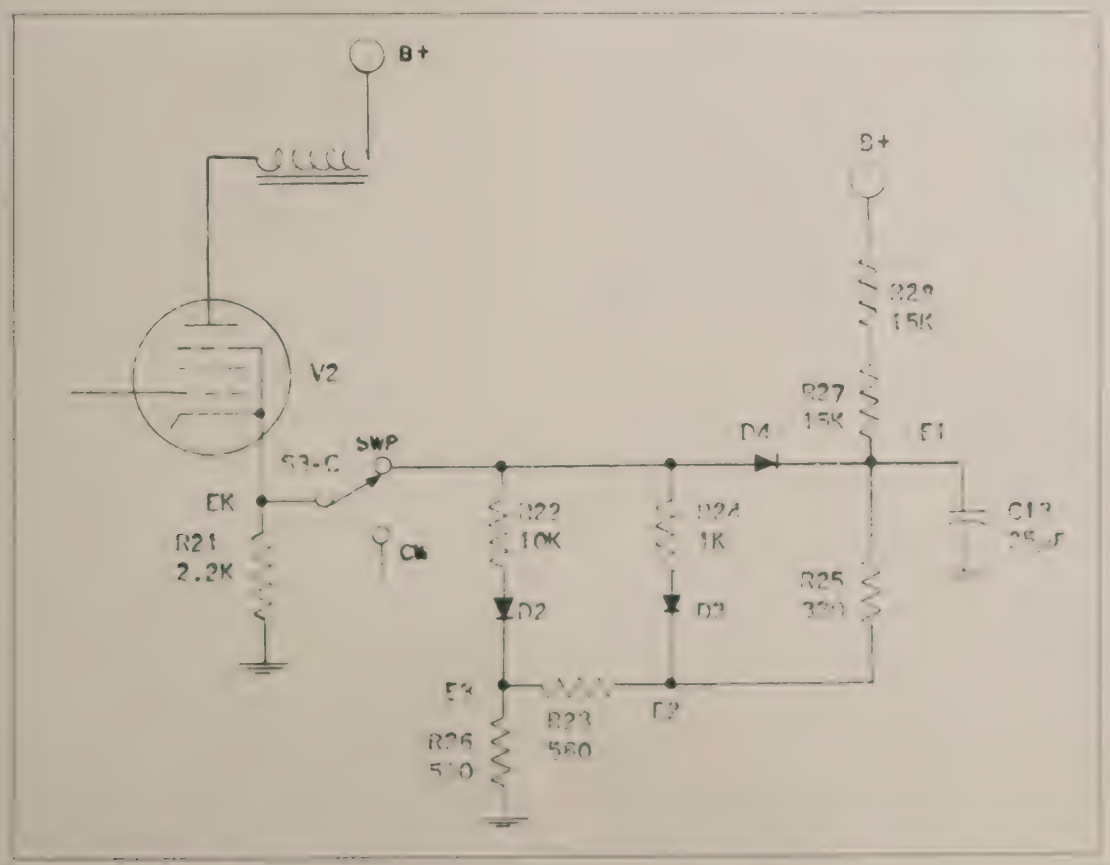


Figure 5-5. Sweep Amplifier V-2, Simplified Circuit

being a direct function of the permeability). Reducing the tank coil inductance raises the rf oscillator frequency. Current through the control winding is the plate current of V-2, the sawtooth amplifier. This current is "swung" by the sawtooth voltage applied to the grid of V-2 to sweep the rf oscillator.

The ferrite rods are a mixture of metallic oxides (predominantly iron oxide) which are scintered at high temperature to produce a polycrystalline atomic structure. The ferrites employed in the LIGNA-SWEEP are characterized by low hysteresis and eddy current losses; necessary properties for their employment at rf. However they do have non-linear saturation characteristics.

The nonlinear saturation characteristics of the ferrites would cause nonlinear frequency deviation of the rf oscillator, if the control winding of the sweep yoke were driven by a linear sawtooth signal. Diodes D-2, D-3 and D-4 in the cathode circuit of V-2 distort the sawtooth current flowing in V-2 and the sweep yoke control winding effectively 'straightening out' the nonlinearity of the ferrites' saturation characteristics. The diodes act as switches which close at appropriate times during the sweep cycle. As each diode switch closes, it reduces the resistance in the cathode of V-2, thus reducing the negative feedback in V-2 and increasing the current through it.

The diodes become effective individually and collectively as the positive going saw-voltage on the grid of V-2 causes an increase of current through the tube. Conduction will take place when the voltage at a diode anode is greater than the voltage at the cathode. Fig. 5-5.

Diode D-2 will conduct when voltage Ek is greater than E-3 (but less than E-2 and E-1 due to the resistive network configuration), effectively placing R-22 and R-26 across R-21, thereby decreasing the negative feedback in the cathode circuit and increasing the gain of the tube. This results in a sharp increase in plate current through V-2.

Ek will continue to increase as the sawtooth voltage on the grid of V-2 increases. Diode D-3 will conduct when Ek equals E-2. Thus the series combination of R-24 and R-23 is placed across R-21 and R-22, producing a second sharp increase in plate current. Finally D-4 conducts when Ek is greater than E-1. C-13 is effectively placed across all cathode resistance, thus completely bypassing the cathode and producing maximum current through V-2.

The action is cumulative and repetitive, furnishing continuous compensation for the nonlinear ferrite response, thus maintaining the frequency sweeps highly linear.

5-3C BALANCED MODULATORS AND CRYSTAL-CONTROLLED OSCILLATORS.

The sweeping oscillators V-3, V-13 will not directly produce frequency sweeps throughout the entire swept frequency range. Therefore, the oscillator is designed to operate directly on all bands except the first and lowest frequency band. In this region, sweeps are produced by heterodyning the 30-mc signal produced in crystal oscillator V-4, with the swept frequency originating in the sweeping oscillators V-3, V-13.

The heterodyning is accomplished in balanced modulator #1. RF transformer T-4 is tuned to 30mc, the resonant frequency of Y-1, and is inductively coupled to T-3; one of two rf transformers used in the modulator. The swept frequency (30-42 mc) from V-3, V-13 is coupled to T-2 the second rf transformer used in the modulator. As is characteristic of balanced modulators, the two input signals are suppressed in the modulating process. The composite signal taken from the center-tap of T-3 contains the sum frequencies (60-72 mc) and the difference frequencies (0-12 mc). Since only the difference frequencies are required, the sum frequencies are removed in the low-pass filter composed of L-8, L-9, L-10 and C-20, C-21.

Crystal markers, for frequency calibration of the response curve developed on the scope, are produced as the swept frequencies from V-3, V-13 pass through the resonant frequency of the crystals switched into the circuit by S-4. The rf pulses thus produced by the marker crystals, are then detected and fed to the trigger amplifiers V-9, V-10 for amplification before going to the pip generator V-11. This portion of the circuitry will be discussed separately in Section 5-3D. Additional crystal markers for the lowest band are generated similarly to that for the 100 kc marker.

Crystal-controlled oscillator V-12, in conjunction with balanced modulator #2, produces suitable swept frequencies to resonate appropriate

crystals for low-band calibration. Cathode-coupled oscillator V-12 incorporates a 28-mc crystal (Y-2) in its cathode circuit. The oscillator output is coupled through T-7 to T-6 in the modulator. Here, the 28-mc signal is mixed with the frequency sweeps originating in sweeping oscillators V-3, V-13. The swept signal is coupled out through a tertiary winding on T-2. As related earlier, the frequency sweeps produced by V-3, V-13 on the first band position, swing above and below the calibrated range (100 kc to 13 mc). The requirement for crystal markers on the first band position could conceivably call for a marker at 100 kc. In which case, the marker crystal would be cut for resonance at 2.1 mc. Assume in this case, that the swept frequency from V-3, V-13 (on the 1st band position) swings beyond 2 mc below center frequency. Then, since the crystal frequencies of the two oscillators V-12, V-4 are displaced by 2 mc, the 2.1 mc marker will appear on the scope trace at exactly 0.1 mc (100 kc). Variable inductor L-13 in series with crystal Y-2, is used to shift the crystal frequency slightly for accurate marker position (frequency) on the scope trace.

Oscillators V-12, V-4 function as Butler cathode-coupled, series-mode, crystal-controlled oscillators. Since the oscillators are very nearly identical, except for operating frequency, discussion will be confined to V-4, the 30-mc oscillator.

T-4 is tuned to 30 mc, resonant frequency of Y-1, the crystal in the cathode circuit. Oscillations appearing at plate A are coupled to grid B by capacitor C-18. Section B operates as a cathode-follower stage, with its cathode output in phase with the plate output of section A. Crystal Y-1 acts as a sharply tuned filter transmitting only 30 mc signals and appears as a low value resistance at its resonant frequency. Thus any 30 mc component of the oscillation which had been transmitted from the plate of the A section to the cathode of the B section is now transmitted through the crystal Y-1 to the cathode of section A. Section A operates as a grounded-grid amplifier and reinforces the oscillations. Thus, positive feedback is furnished to sustain oscillations only at the crystal frequency.

5-3D TRIGGER AMPLIFIER AND PIP GENERATOR CIRCUITS.

The detected trigger pulses produced by the marker crystals are dc coupled to the cascaded four-stage amplifiers V-9, V-10. Inter-stage coupling between the 2nd and 3rd stages incorporates the PIP ADJ control R-104 and R-66B (one half of the dual RF LEVEL control pot). The two sections of R-66 work in reverse of each other i.e., when the RF LEVEL control is rotated clockwise, R-66A acts to increase the rf output, but R-66B reduces the marker signal amplitude at section A grid of V-10, thus keeping the pip level at the grid of section A in V-10 substantially constant for all settings of the RF LEVEL control. PIP ADJ control R-104 permits external adjustment of the crystal marker signal presented to the grid in section A of V-10.

Diode D-11, in the grid circuit of section B of V-10, clips the negative portion of the trigger pulse. The positive portion of the trigger is amplified in section B (appearing as a negative pulse on the plate of section B) and then capacitively coupled to the input grid of V-11, the pip generator. A type 12AT7 operates as a one-shot multivibrator, with section B normally biased to cutoff, due to the direct coupling between plate #1 and B section grid. The input grid (section A) is essentially at ground during the quiescent state.

The incoming negative trigger decreases the current through section A causing a rise in the plate voltage of section A. The rise in plate potential at plate A is directly coupled to grid B, driving it less negative, permitting conduction in section B after which the circuit immediately returns to its original state and awaits the next trigger. The complete cycle occurs very rapidly. Internal PIP ADJ pot R-116 determines the firing point of V-11 by establishing the cathode bias derived from B+ through R-118. INCREASE control pot R-119 permits adjustment of pip amplitude at J-3.

5-3E AUTOMATIC GAIN CONTROL CIRCUITS.

The agc circuits incorporate a voltage-doubler detector, first and second agc amplifiers, and a cathode-follower output tube. These circuits are individually discussed.

A. Agc Detector (diodes D-9 and D-10).

Two high-frequency diodes are used in a voltage-doubler detector circuit to sample the rf output and provide an error voltage to the agc amplifiers. The detected output is dc coupled to the grid of the first agc amplifier V-6.

On positive half-cycles of the rf, diode D-10 conducts and charges C-27 to a voltage approximately equal to the negative peak-value of the rf. On negative half-cycles of the rf, diode D-9 conducts charging C-42 to the negative peak-voltage of the r-f. The voltages on the capacitors add in series to give a total negative output approximately equal to twice the negative peak value of the rf.

B. First Agc Amplifier (V-6).

This tube amplifies the error voltage from the agc detector and also incorporates in its grid circuit the RF LEVEL control R-66A. The effective voltage on the grid of V-6 is the sum of the negative voltage derived from the detector and the positive voltage derived from the RF LEVEL control, plus its associated resistive network R-65 and R-67. The setting of the RF LEVEL control will determine the average grid bias for V-6 and eventually, the average plate voltage for the type 5718 tubes in the sweeping oscillator V-3, V-13.

C. Second Agc Amplifier (V-7).

This tube has its grid directly coupled to the plate of the 1st agc amplifier and further amplifies the error voltage. Diode D-16 in the plate circuit of V-7 is a limiter which prevents the plate voltage of the sweeping oscillators V-3 and V-13 from rising to levels which would be harmful to them during the retrace or blanked portion of the sweep.

D. Agc Cathode-Follower Output (V-8).

A type 6BK7 is used as a cathode-follower output tube. The cathodes of V-8 supply plate voltage directly to the rf oscillator tubes through the center-tapped plate tank coils.

The error voltage applied to V-6 appears on the grids of V-8 greatly amplified; the cathodes of V-8 and therefore, the plates of the rf oscillator tubes follow the error voltage and maintain the rf output constant. Variable capacitor C-28 provides adjustment of the negative feedback from the cathode-follower output to the grid of the 2nd agc amplifier. The negative feedback stabilizes the amplifier and prevents it from oscillating or ringing.

5-3F REGULATED POWER SUPPLY CIRCUITS.

The voltage regulator circuits compensate for power-line voltage fluctuations or power-supply load changes. The regulator circuits sense these changes and respond electronically to maintain the output voltage constant.

Operation of the regulator circuit can be analyzed by considering a power-line fluctuation presenting a voltage rise at the primary of T-1. The voltage rise at the primary of T-1 will cause the power supply output voltage (the B^+ voltage) to rise. The increase in the B^+ voltage increases the current through the neon tubes I-3, I-4, thus raising the grid bias of V-204, permitting it to conduct more current and causing a drop in its plate voltage.

Since the plate of V-204 is tied directly to the grids of V-205, these are driven less positive, reducing the current flow through the tube and causing a drop in cathode potential across R-202, which lowers the voltage at the grids of V-202, V-203.

When the grids of V-202 and V-203 are made less positive, current through these tubes is decreased, causing a decrease in potential at their cathodes, which furnish the regulated 250V B^+ voltage. Thus, the increase of line voltage was compensated by an opposite voltage developed in the regulator circuit, keeping the output voltage constant.

The type NE-2 neon tubes feed back slow transients and long-term line voltage fluctuations to the grid of V-204. Voltage changes of short duration (sharp transients) are compensated by capacitor C-204. Regulator tube V-206 clamps the cathode of V-204 at 105 volts thereby establishing the 105V B+ output, since V-206 will discharge any potential above 105 volts.

Conversely, a power-line fluctuation presenting a lower voltage to the primary of T-1, will cause the regulating circuit to act in reverse of that for a higher voltage as dealt with before. The regulating circuits also remove any residual ripple from the filter output. The neon tubes and capacitor C-204, see ripple as voltage changes and respond, as previously related, by presenting an opposite compensating voltage to maintain the output smooth and of constant amplitude.

Changes of power-supply load are also reflected back to the regulator circuit and dealt with in similar fashion. Output capacitor C-201B is of sufficient capacity to retain a steady charge and further stabilize the output voltage.

SECTION VI
MAINTENANCE

6-1 TROUBLE-SHOOTING.

If operation of the LIGNA-SWEEP appears to be defective in any respect, determine that the cause of improper operation is not in the scope, circuit under test, or in the interconnecting cables. If a process of elimination indicates that the trouble originates in the LIGNA-SWEEP, continue the diagnosis by attempting to determine which circuit is malfunctioning. Preliminary visual inspection should include:

Step 1 - Determine that all tubes are fully seated in their respective sockets and all filaments are lit.

Step 2 - Inspect fuse F-1 for open circuit, or intermittent contact within the fuse holder.

Step 3 - Check regulated B+ voltage and readjust, if necessary, to 250 volts, as measured between chassis-ground and the junction of R-211 and C-205 in the power supply section.

If inspection proves that conditions covered in *Steps 1* through *3* above are in order, continue the inspection by considering the symptoms and causes listed below.

Note: The most common cause of instrument malfunction is due to weak or defective electron tubes and diode failure. Trouble-shooting procedure would include the testing of tubes for short circuit, open circuit, microphonics, gassyness or other signs of defectiveness. A known reliable dynamic tube tester should be used for these checks.

Voltage and resistance measurements are contained in Tables 6-2 thru 6-5. Information contained in these tables will be helpful in checking out specific circuits referenced in the following listing of symptoms and causes.

No horizontal deflection on scope; absence of sweep output at J-1.

Check sweep generator V-1 and associated circuitry.

Sweep width control R-21 ineffective.

Indicates inoperative sweep amplifier stage V-2.

No rf output at J-2; indicated by lack of vertical deflection on scope for all band positions.

Check tubes in agc circuit (V-6, V-7 and V-8); check sweeping oscillator (V-3, V-13) and associated circuitry.

No rf output on first band position only.

Indicates inoperative 30-mc crystal oscillator stage V-4.

No markers on first band position only.

Indicates inoperative 28-mc crystal oscillator stage V-12.

Absence of markers on all bands.

Check trigger amplifier tubes V-9, V-10 and pip generator V-11. Signal tracing with the scope is recommended. Check for trigger pulse at the input grid of V-9. Absence of a pulse here indicates trouble is in crystal circuits or in switches S-4, S-2. If trigger pulse is present at the input grid of V-9, proceed from plate to grid through the marker generator circuit.

No agc control; vertical amplitude of scope trace changes as bands are changed and/or the individual bands are not flat.

a - Low amplitude indicates faulty agc input stage V-6.

b - Rise of amplitude indicates faulty 2nd agc amplifier V-7.

No baseline on scope (no blanking).

Check diode D-1, blanking voltage limiter diode. When checked with an ohmmeter, a good diode will have high forward resistance and low back re-resistance.

Loss of voltage regulation, evidenced by low or high B+.

Check regulated 250 volts B+ by varying R-212. Voltage should swing above and below the 250 volt point. Average swing is between 225 and 270 volts.

a - No voltage swing and low output indicates inoperative 12AU7 (V-205).

b - No voltage swing and high output indicates inoperative 6AG5 (V-204).

c - High B+ at 105 volt regulated point indicates faulty OB2 (V-206).

Individual components associated with the above circuits should also be checked out.

TABLE 6-2, VOLTAGE MEASUREMENTS FOR THE LIGNA-SWEEP CP

SET ALL POTENTIOMETER CONTROLS FULLY COUNTERCLOCKWISE, EXCEPT THE SWEEP RATE CONTROL, WHICH IS SET FOR 60 CYCLE LINE LOCK; SET S-3 IN SWEEP POSITION, SET THE BAND SELECTOR TO THE 20 - 30 MC RANGE.

NO.	TUBE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
V-1	6J6	170	106	6.3VAC	GROUND	-37	-46	GROUND		
V-2	6V6	---	6.3VAC	250	160	0	---	GROUND	13	
V-3	5718	-13	---	6.3VAC	---	GROUND	GROUND	---	140	
V-4*	6BK7	60	-4	3	6.3VAC	GROUND	70	GROUND	1.8	---
V-5	6E5	6.3VAC	44	-.85	250	GROUND	GROUND			
V-6	6AL6	-.79	GROUND	6.3VAC	GROUND	5	12	GROUND		
V-7	6AU6	5	8.4	6.3VAC	GROUND	98	110	8.4		
V-8	6BK7	420	100	116	6.3VAC	GROUND	420	100	116	GROUND
V-9	12AU7	42	0	.96	6.3VAC	6.3VAC	44	0	1	GROUND
V-10	12AU7	48	0	1	6.3VAC	6.3VAC	48	0	.96	GROUND
V-11	12AT7	40	-.3	GROUND	6.3VAC	6.3VAC	270	40	44	GROUND
V-12*	6BK7	145	-7.5	2.7	6.3VAC	GROUND	150	GROUND	2.1	GROUND
V-13	5718	-13	---	GROUND	---	GROUND	6.3VAC	---	140	

*THESE VOLTAGE READINGS WERE TAKEN WITH A 100K OHM RESISTOR IN SERIES WITH THE VTVM PROBE TO AVOID LOADING THE MEASURED CIRCUITS. BAND SELECTOR SWITCH WAS SET TO THE .1 TO 12 MC RANGE.

TABLE 6-3, RESISTANCE MEASUREMENTS FOR THE LIGNA-SWEEP CP

NO.	TUBE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
V-1	6J6	110 K	110 K	---	---	2 M	3.3 M	GROUND		
V-2	6V6	---	---	15 K	27 K	300	---	---	850	
V-3	5718	17 K	---	---	---	GROUND	GROUND	---	0	
V-4	6BK7	0	10 K	620	---	---	0	GROUND	620	---
V-5	6E5	---	900 K	10 M	12 K	GROUND	---			
V-6	6AU6	1.2 M	GROUND	---	---	3.3 M	18 K	GROUND		
V-7	6AU6	3.3 M	12 K	---	---	110 K*	24 K	12 K		
V-8	6BK7	250 K	110 K*	0	---	---	250 K	110 K*	0	GROUND
V-9	12AU7	120 K	120 K	470	---	---	120 K	100 K	470	---
V-10	12AU7	110 K	27 K	470	---	---	120 K	80 K	470	---
V-11	12AT7	210 K	100 K	GROUND	---	---	54 K	210 K	95 K	---
V-12	6BK7	0	10 K	230	---	GROUND	---	GROUND	230	GROUND
V-13	5718	17 K	---	---	---	GROUND	GROUND	---	0	

*THESE READINGS WERE TAKEN WITH AN R.C.A. VOLTOHMYST SET TO THE RX10K POSITION.

6-4 ALIGNMENT AND ADJUSTMENT.

Normal aging or the replacement of components and tubes may necessitate realignment and recalibration of the instrument. Should it become necessary to realign and recalibrate the instrument, it is recommended that the sequential procedures outlined below be adhered to.

Test Equipment Required:

a. Detector Circuit (See Fig. 6-1 for recommended circuit and construction details).

b. Two rf signal generators, each having a frequency range somewhat greater than the LIGNA-SWEEP (One generator should be capable of at least 1-volt metered output).

c. CW generator having a frequency range greater than the LIGNA-SWEEP.

d. Oscilloscope.

e. Vacuum-tube voltmeter.

f. Interconnecting cables.

A. Sweep Linearity Adjustment.

Potentiometer R-22 provides a means of adjusting linearity of the swept frequency ranges, by establishing the average cathode bias for sawtooth amplifier V-2. Since the performance of this stage may vary with individual 6V6 tubes, sweep linearity should be checked if this tube is changed. If the marker circuits are functioning, linearity can be quickly checked by inserting appropriate frequency marks. If markers are not available, use either of the following methods to check linearity.

Method 1 -

Connect the rf output from the LIGNA-SWEEP to the Y-axis input terminals on the scope, thru the detector circuit as illustrated in Fig. 6-1. To obtain a scope display showing the entire swept range of each band, plus beats indicating band limits, feed in through the detector, signals from the two separate signal generators. A "T" connector may be used to accommodate inputs from both oscillators simultaneously. The generators should

have a frequency range somewhat greater than that of the LIGNA-SWEEP.

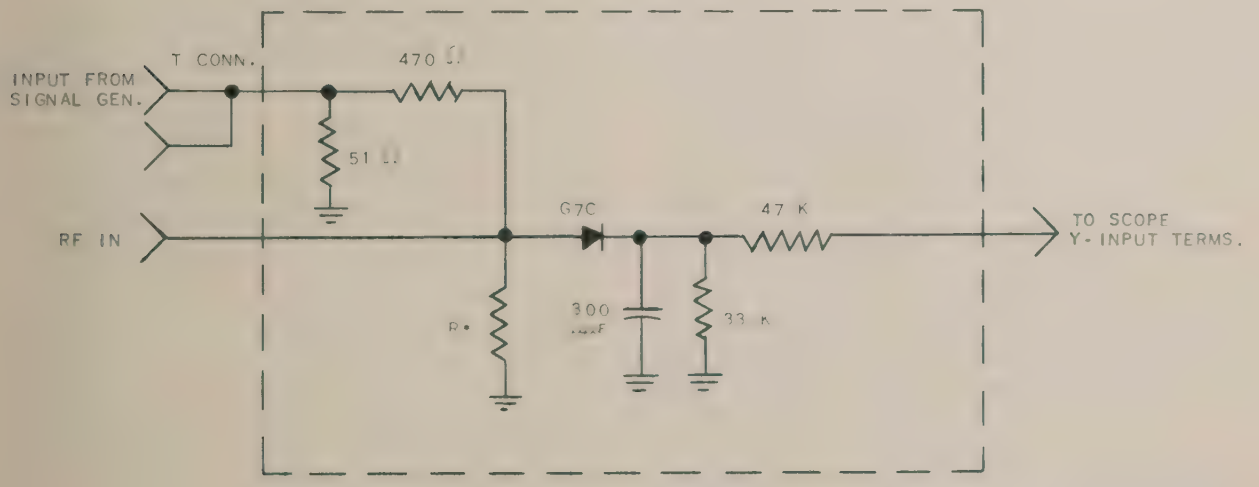
Place the BAND SELECTOR switch (S-2) in position #2. (Band #1 is aligned last, since frequency sweeps on this band are obtained by heterodyne techniques). Set one signal generator to the center frequency of the range and adjust generator frequency until a beat is seen at the center of the sweep display. Set the 2nd generator to approximately 5 mc. Two beats should be visible, one on each side of center frequency.

Adjust R-22 for equal spacing of the beats. This should occure at approximately mid-range on the pot. Now check the linearity of the highest frequency band using the same technique. If it is necessary to reset R-22 to improve linearity on the high band, then a compromise will have to be effected between the linearity on the low band and that on the high band. Over-all linearity will be rechecked after the other circuits have been aligned.

Method 2 -

An alternative method of checking sweep linearity makes use of a 1-mc crystal oscillator and harmonics generated from it. If this signal source is injected into the detector box, in place of that from the variable frequency generator, frequency marks will appear at 1-mc intervals on the detected sweep display, permitting accurate calibration of sweep linearity.

Linearity can also be checked by injecting the output from a single signal generator into the detector box and using the resultant beat to make point-by-point frequency determinations across the width of the sweep.



CONSTRUCTION: ALL COMPONENTS SHOULD BE MOUNTED IN A SMALL METAL CASE AND COMPONENTS PHYSICALLY ISOLATED FROM METAL CASE TO KEEP STRAY CAPACITANCES LOW. INPUT AND OUTPUT TERMINALS TO BE COMPATIBLE WITH TERMINATIONS ON INTERCONNECTING CABLES.

VALUE OF R* DEPENDS UPON LOAD REQUIREMENT OF CIRCUIT UNDER TEST.

Figure 6-1, External Detector Circuit.

B. Frequency Calibration (CW Operation).

The LIGNA-SWEEP frequency dial is initially calibrated with the instrument operating as a cw generator. For each band position, the actual tuning should extend above and below the calibrated range to provide overlap between ranges. For checking the frequency calibration an external cw generator is required.

Procedure:

Set the LIGNA-SWEEP for cw operation and connect its RF OUTPUT jack to the detector shown in Fig. 6-1. Feed the external cw-generator output into the detector and the output of the detector into the Y-axis input on the scope. Set the BAND SELECTOR switch S-2 to the 2nd band position. (The 1st band requires a special procedure which will be covered later.) Turn the FREQUENCY dial (C-15) completely clockwise (plates fully meshed, lower frequency limit of the oscillator). Adjust the cw-generator output frequency to approximately 12 mc. Vary this frequency until the beat is visible on the scope. If the frequency of the LIGNA-SWEEP cw output is low, carefully spread the turns of L-2A, to reduce the inductance (raise the frequency), or conversely, compress the turns to increase the inductance and lower the frequency.

Care should be taken to find the fundamental frequency and avoid calibrating against one of the harmonics. Considerable care must also be exercised when coil turns are spread or compressed to avoid breaking a lead or damaging a ferrite core.

Band-spread on the 2nd range will be approximately 11.5 to 21 mc. The procedure should be repeated for band positions 3 thru 6. The 1st band will be calibrated later.

C. Sweep Width and Centering Adjustments.

Having adjusted the sweep linearity and calibrated the instrument for cw operation, the next step is to adjust the sweep widths and center frequencies for each band. Equipment required includes a scope, cw generator and external detector.

Procedure to Align Band B:

Step 1 - Set the frequency control to the lowest calibrated center frequency (12 mc).

Step 2 - Connect an external cw signal generator to the detector box (Fig. 6-1). Set the generator to 12 mc and observe the beat on the scope trace.

Step 3 - Now turn the SWEEP WIDTH control fully clockwise (max. swp. width). The sweep width should be 60% of center frequency (60% of 12 mc = 7.2 mc). The 12-mc beat should appear in the center of the scope trace.

Step 4 - If it is necessary to change the sweep width, the value of resistor R-47 should be changed. To increase the sweep width, decrease the value of R-47.

Step 5 - If the beat does not appear in the center of the trace, it can be relocated by changing the value of R-54. Increasing the value of R-54 moves the beat to the right. Conversely, decreasing the value will move the beat to the left. A large change of centering resistor value may effect the sweep width, requiring further tailoring of R-47.

This procedure should be repeated for the remaining band positions (except band #1). If difficulty is encountered in obtaining proper sweep width on all bands, it may be due to insufficient sweep voltage; in which case, selection of a new 6V6 tube for V-2 position may provide the required output.

D. Adjustment of Sweep Oscillator and AGC Output.

The agc circuit furnishes plate potential for the sweeping oscillators V-3, V-13, to keep the oscillator output constant from one band to the next. Oscillator output is approximately 1 volt maximum. A sample of this voltage is fed to the agc input tube V-6. Since the agc circuit requires about 1 volt input to function properly, it can be seen oscillator output must be adjusted to fulfill this requirement. However, the agc input voltage can vary only about 8 db, so the oscillator output must not exceed this limit. Thus, certain requirements are established and must be fulfilled for proper operation of the agc.

If the pick-off loops L-2B, L-3B, etc., are coupled too tightly, the oscillator may be loaded down preventing oscillation. Small adjustment of the agc can be accomplished by spreading or compressing the turns on the pick-off loops. This method and a more comprehensive treatment follows.

Procedure:

An rf signal generator capable of at least 1-volt metered output is required. Calibrate the scope for a convenient 1-volt reference by adjusting the Y-gain control and scope Y-input attenuator. Now connect the RF OUT terminal on the LIGNA-SWEEP through the external detector to the Y-axis input terminals on the scope. Since there are losses in the detector, readjust the scope controls to the previously established references.

Switch to band position #2 and set the RF LEVEL control R-66 to maximum (fully clockwise) with no attenuation in. The agc should be holding with rf output at 1 volt or slightly higher. Remove the 2nd agc amplifier tube V-7 to disable the agc action. Tune the FREQ. control to find the point of minimum oscillator output. This point should be just above the agc take-hold point. By shunting L-2B with a suitable resistance (3.3 to 10K) the output can be brought down to approximately 1 volt.

Replace the 2nd agc amplifier tube. As the tube warms up, observe the agc take hold. The output should be flat as the sweeping oscillator is tuned across the entire range. If the agc input voltage is less than 1 volt, biasing on the input stage can be adjusted to have the agc take hold at a lower voltage. To do this, increase the value of R-65, dc bias source for the input grid of V-6. By varying the RF LEVEL control, the rf output should be increased or decreased over 6 db. Extent of variation can be adjusted by changing the value of R-67 in the grid circuit of V-6. To increase the range, decrease the value of R-67. Judicious lead dress around the sweeping oscillator circuit should serve to eliminate spurious responses in the output.

Trimmer capacitor C-28 furnishes negative feedback to the 2nd agc amplifier and can be adjusted to remove the spike appearing at the beginning of the sweep.

E. Alignment of Band #1.

Sweeps on the 1st band position are obtained by mixing the output from the 30-mc crystal-controlled oscillator V-4, with the sweeping oscillator output. Mixing is accomplished in balanced modulator #1. The 30-mc modulating signal is removed in the process and the sum frequencies are filtered out in the low pass filter. The difference frequencies are used for sweeps on this band. Alignment of the first band and overall calibration of the previously calibrated bands should now be rechecked.

Procedure:

Variable rf transformer T-4 is tuned for maximum oscillator output. To do this, measure the negative voltage on the number two grid of V-4, placing a 200K resistor in series with the vtvm probe to avoid loading the circuit. Adjust the slug in T-4 for maximum meter reading.

Next, rotate the FREQ. control to zero frequency indication on the dial. The beat should be visible near the center of the sweep display. If the beat is to the right of center, spread the turns of L-2A; conversely, compressing the turns will move the beat to the left. Now, rotate the FREQ. control counterclockwise, to move beat to extreme left of sweep display; the swept band should go from zero to 12 mc minimum. Should the sweep width be too narrow, decrease the value of the sweep width resistor R-46. The upper reach of the swept band will probably be in the region of 15 mc.

Since the sum frequencies are not used, the low-pass filter should be tuned to cut off all frequencies above approximately 15 mc. The filter should also provide flat response to the desired frequencies. To check filter cutoff and response, feed the cw-generator output through the detector to the Y-axis input terminals on the scope. Set the SWEEP WIDTH control at maximum and observe the swept display. Tune the cw generator to move the beat to the cutoff region. Care should be taken to avoid using the beat produced when the sweep passes the 2nd harmonic (15 mc) of the 30 mc oscillator. Varying the cw-oscillator tuning dial will disclose the true birdie. Now tune the filter by adjusting the slugs in L-8, L-9 and L-10 for cutoff at 15 mc.

F. Adjustments to Synchronize Dial Calibration with Center Frequency.

It is desirable to have the dial calibrations coincide with the center frequency of the sweeps. Since the instrument has already been calibrated for cw operation, the dial readings can be made to coincide. Panel control marked ZERO ADJ furnishes a means of adjusting the center frequency to coincide with the dial reading. Tuning eye V-5 provides visual indication of zero beat.

Procedure:

If necessary, a new value for R-18 (resistor in series with the ZERO ADJ pot R-17) can be selected to place the zero beat at center-range of the zero adjust pot.

RF output on the first band should be at least 0.25 volt, and adjustable over a 6-db range by the BFO RF LEVEL control R-121.

G. Adjustments for Zero-Frequency Indication On Tuning-Eye Indicator V-5.

If the zero-frequency indicator V-5 does not respond when the ZERO ADJ control R-17 is varied, a new value for R-18 should be selected.

Procedure:

Step 1 – Provide a connection between the RF OUT jack J-2 and the Y-input terminals on the scope. Connect a patch cord between the SWEEP OUTPUT jack J-1 and the X-axis input terminals on the scope.

Step 2 – Set the SWEEP-CW selector switch S-3 to SWEEP position.

Step 3 – Set the SWEEP WIDTH control to minimum (fully counterclockwise).

Step 4 – Set the zero frequency mark on band 1 of the frequency dial under the hairline indicator.

Step 5 – The zero beat should appear at the center of the scope trace, if L-2A was correctly adjusted, as outlined in paragraph C, part 5 of Section 6-1.

If the zero beat is not correctly centered, it can be by shifting the frequency of V-3, V-13, by compressing or spreading the turns on L-2A.

Step 6 – Set the SWEEP-CW switch to CW position.

Step 7 – Set the ZERO-ADJ control R-17 to the center of its range.

Step 8 – A new value for R-18 can now be selected so that the tuning-eye indicator will indicate zero frequency as the ZERO-ADJ control is varied.

TABLE 6-4, VOLTAGE MEASUREMENTS FOR LIGNA-SWEEP CP POWER SUPPLY SECTION

NO.	TUBE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
V-201	5Y3	---	430	---	380VAC	---	380VAC	---	430	
V-202	6AQ5	265	270	6.3VAC	6.3VAC	420	420	---		
V-203	6AQ5	265	270	6.3VAC	6.3VAC	420	420	---		
V-204	6AG5	106	108	6.3VAC	6.3VAC	255	200	108		
V-205	12AU7	420	255	265	6.3VAC	6.3VAC	420	255	265	6.3VAC
V-206	OB2	---	GROUND	---	GROUND	108	---	GROUND		

TABLE 6-5, RESISTANCE MEASUREMENTS FOR LIGNA-SWEEP CP POWER SUPPLY SECTION

NO.	TUBE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
V-201	5Y3	---	330 K*	---	160	---	160	---	330 K*	
V-202	6AQ5	150 K	13 K	---	---	330 K*	330 K*	---		
V-203	6AQ5	150 K	13 K	---	---	330 K*	330 K*	---		
V-204	6AG5	260 K	24 K	---	---	580 K*	17 K	24 K		
V-205	12AU7	330 K*	580 K*	150 K	---	---	330 K*	580 K*	150 K*	---
V-206	OB2	---	GROUND	---	GROUND	24 K*	---	GROUND		

*THESE READINGS HOLD IF THE CAPACITORS IN THE CIRCUIT ARE FULLY DISCHARGED.

6-5 RESHIPMENT INSTRUCTIONS.

Permission to return equipment should in every case be obtained from the factory or an accredited Kay representative before return shipment is made.

If the LIGNA-SWEEP is returned to the factory for repairs, it should be wrapped in protective paper and then adequately padded with soft wadding to cushion the instrument during transit. The wrapped and padded unit should then be packed in a wooden box or suitable carton.

A packing slip should be included in the carton furnishing identification of the shipper. The packing slip should also reference the instrument type and serial number. A statement pertaining to the extent of malfunction should be included to acquaint service personnel with the purpose of returning the instrument. Return shipment must be made with shipping charges prepaid.

SECTION VII
PARTS LISTS

7-1 PARTS LIST FOR LIGNA-SWEEP MODEL CP.

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	CAPACITORS: (ALL CAPACITANCES IN μμF, 500 VOLTS UNLESS OTHERWISE SPECIFIED.)	
C-1	150, SILVER MICA (MINIATURE)	6359-9
C-2	150, SILVER MICA	6359-10
C-3	2000, MICA	6359-34
C-4	2000, MICA	6359-34
C-5	0.01μF, CERAMIC DISC	6360-6
C-6	0.01μF, CERAMIC DISC	6360-6
C-7	0.02μF, CERAMIC DISC	6360-7
C-8	0.25μF, 400V (METALITE)	6354-6
C-9	100, SILVER MICA (MINIATURE)	6359-7
C-10	0.25μF, 400V, PAPER	6353-6
C-11	NOT USED	
*C-12 A-B	20/20μF, 475V, ELECTROLYTIC	6355-8
C-13	25μF, 25V, ELECTROLYTIC	6355-4
C-14	7.5, CERAMIC (TUBULAR)	6361-29
C-15 A-B	3.5-22.5/3.5-225, VARIABLE	5225
C-16	1000, CERAMIC (TUBULAR)	6361-25
C-17	1000, CERAMIC (TUBULAR)	6361-25
C-18	100, SILVER MICA (MINIATURE)	6359-7
C-19	0.01μF, CERAMIC DISC	6360-6
C-20	240, SILVER MICA	6359-15
C-21	240, SILVER MICA	6359-15
C-22	0.1μF, 400V (METALITE)	6354-4
C-23	NOT USED	
C-24	0.01μF, CERAMIC DISC	6360-6
C-25	1000 CERAMIC (TUBULAR)	6361-25
C-26	0.01μF, CERAMIC DISC	6360-6
C-27	1000, CERAMIC (TUBULAR)	6361-25
C-28	4-30, CERAMIC TRIMMER	6358-6
C-29	1000, CERAMIC (TUBULAR)	6361-25
C-30	0.2μF, 75V, CERAMIC DISC	6360-9
C-31	0.2μF, 75V, CERAMIC DISC	6360-9
C-32	1000, CERAMIC (TUBULAR)	6361-25
C-33	1000, CERAMIC (TUBULAR)	6361-25
C-34	1000, CERAMIC (TUBULAR)	6361-25
C-35	0.2μF, 75V, CERAMIC DISC	6360-9
C-36	0.2μF, 75V, CERAMIC DISC	6360-9
C-37	1000, CERAMIC (TUBULAR)	6361-25
C-38	100, SILVER MICA	6359-8
C-39	33, CERAMIC (TUBULAR)	6361-13
C-40	7.5 CERAMIC	6361-29
C-41	0.05μF, 200V (METALITE)	6354-1
C-42	390, SILVER MICA	6359-19
C-43	390, SILVER MICA (MINIATURE)	6359-20
C-44	0.02μF, CERAMIC DISC	6360-7
C-45	1000, CERAMIC (TUBULAR)	6361-25
C-46	5, CERAMIC (TUBULAR)	6361-5
C-47	1000, CERAMIC (TUBULAR)	6361-25
C-48	500, CERAMIC FEED THRU	6356-1
C-49	1000, CERAMIC (TUBULAR)	6361-25
C-50	1000, CERAMIC (TUBULAR)	6361-25
C-51	100, SILVER MICA (MINIATURE)	6359-7
C-52	1000, CERAMIC (TUBULAR)	6361-25
C-53	1000, CERAMIC (TUBULAR)	6361-25
C-54	500, CERAMIC, FEED THRU	6356-1
C-55	500, CERAMIC, FEED THRU	6356-1
C-56	500, CERAMIC, FEED THRU	6356-1
C-57	0.01μF, CERAMIC DISC	6360-6
C-58	NOT USED	
C-59	NOT USED	
C-60	3, CERAMIC FEED THRU	1996

* C-12 A-B AND C-201 A-B ARE COMBINED IN ONE UNIT.

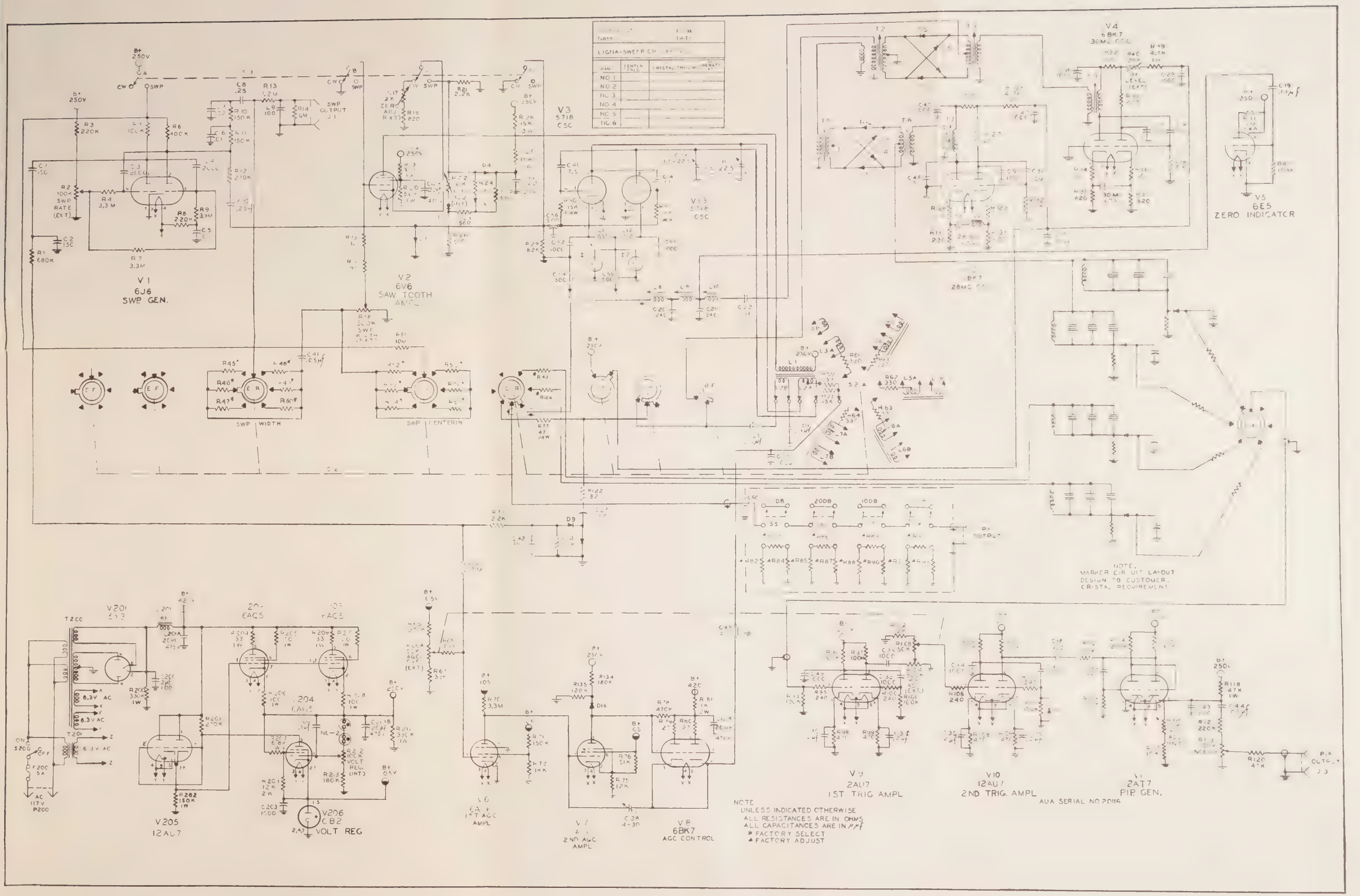


Figure 7-1, Ligna-Sweep Model CP Schematic, KD-5072-E

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
D-1 THRU D-8	1N294 GERMANIUM DIODES	6357-5
D-9 AND D-10	G7C GERMANIUM DIODES	6357-4
D-11 THRU D-15	1N294 GERMANIUM DIODES	6357-5
D-16	1N537 GERMANIUM DIODE	6357-6
I-1	LIGHT INDICATOR #44	249
I-2	LIGHT INDICATOR #44	249
J-1	938 A & Z BINDING POST	257
J-2	CONNECTOR UG-185/U	204
J-3	938 A & Z BINDING POST	257
L-1	SATURABLE REACTOR	4699
L-2 A-B	SPECIAL BAND COIL	L2/5072E
L-3 A-B	SPECIAL BAND COIL	L3/5072E
L-4 A-B	SPECIAL BAND COIL	L4/5072E
L-5 A-B	SPECIAL BAND COIL	L5/5072E
L-6 A-B	SPECIAL BAND COIL	L6/5072E
L-7 A-B	SPECIAL BAND COIL	L7/5072E
L-8	COIL, SPECIAL, SLUG TUNED	L8/5072E
L-9	COIL, SPECIAL, SLUG TUNED	L9/5072E
L-10	COIL, SPECIAL, SLUG TUNED	L10/5072E
L-11	12 MICROHENRY FILAMENT CHOKE	L11/5072E
L-12	12 MICROHENRY FILAMENT CHOKE	L12/5072E
L-13	COIL, SPECIAL, SLUG TUNED	L13/5072E

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	(UNLESS OTHERWISE INDICATED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.)	
R-1	680K	6841-E
R-2	100 K POT, VARIABLE	121
R-3	220 K	2241-E
R-4	3.3 M	3351-E
R-5	100 K	1041-E
R-6	100 K	1041-E
R-7	3.3 M	3351-E
R-8	220 K	2241-E
R-9	3.9 M	3951-E
R-10	150 K	1541-E
R-11	150 K	1541-E
R-12	270 K	2741-E
R-13	1.2 M	1251-E
R-14	1 M	1051-E
R-15	240	2411-E
R-16	68	6801-E
R-17	2 K POT, VARIABLE	95
R-18	820	8211-E
R-19	33 K, 1 WATT	3331-G
R-20	56 K, 1 WATT	5631-G
R-21	2.2 K	2221-E
R-22	10 K POT, VARIABLE	110
R-23	560	5611-E
R-24	1 K	1021-E
R-25	330	3311-E
R-26	510	5111-E
R-27	15 K, 2 WATT	1531-H
R-28	15 K, 2 WATT	1531-H
R-29	82 K	8231-E
R-30	15 K, ¼ WATT	1531-C
R-31	15 K, ¼ WATT	1531-C
R-32	100	1011-E
R-33	470	4711-E
R-34	10	1001-E
R-35	620	6211-E
R-36	10	1001-E
R-37	620	6211-E
R-38	10 K	1031-E
R-39	4.7 K, 1 WATT	4721-G
R-40	25 K POT, VARIABLE	113
R-41	1 M, ¼ WATT	1051-C
R-42	10 M	1061-E
R-43 THRU R-50	FACTORY SELECTED	
R-51	10 M	1061-E
R-52 THRU R-57	FACTORY SELECTED	
R-58	500 K POT, VARIABLE	126
R-59	15 K	1531-E
R-60	330	3311-E
R-61	330	3311-E
R-62	330	3311-E
R-63	330	3311-E
R-64	330	3311-E
R-65	270 K	2741-E
R-66 A-B	50 K/50 K DUAL POT	77
R-67	33 K	3331-E
R-68	10 M	1061-E
R-69	1.2 M	1251-E
R-70	3.3 M	3351-E
R-71	150 K	1541-E
R-72	18 K	1831-E
R-73	2.2 K	2221-E
R-74	100 K	1041-E
R-75	12 K	1231-E
R-76	51 K	5131-E
R-77	47, ¼ WATT	4701-C
R-78	470 K	4741-E
R-79	27	2701-E
R-80	27	2701-E
R-81	1 K, 2 WATT	1021-H
R-82 THRU R-93	FACTORY SELECTED	
R-94	120 K	1241-E
R-95	240	2411-E

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
R-96	100 K	1041-E
R-97	100 K	1041-E
R-98	470	4711-E
R-99	470	4711-E
R-100	240	2411-E
R-101	100 K	1041-E
R-102	62 K	6231-E
R-103	NOT USED	
R-104	500 K POT. VARIABLE	126
R-105	240	2411-E
R-106	100 K	1041-E
R-107	100 K	1041-E
R-108	470	4711-E
R-109	470	4711-E
R-110	240	2411-E
R-111	100 K	1041-E
R-112	20 K	2031-E
R-113	100 K	1041-E
R-114	200 K	2041-E
R-115	39 K	3931-E
R-116	10 K POT. VARIABLE	109
R-117	10 K	1031-E
R-118	47 K, 1 WATT	4731-G
R-119	100 K POT. VARIABLE	121
R-120	47 K	4731-E
R-121	220 K	2241-E
R-122	82	8201-E
R-123	NOT USED	
R-124	NOT USED	
R-125	100	1011-E
R-126	4.7 K, 1 WATT	4721-G
R-127	470	4711-E
R-128	10	1001-E
R-129	10	1001-E
R-130	220	2211-E
R-131	220	2211-E
R-132	10 K	1031-E
R-133	15 K	1531-E
R-134	180 K	1841-E
R-135	120 K	1241-E
S-1	NOT USED	
S-2	SWITCH, ROTARY, 6 POSITIONS	5416
S-3	SWITCH, LEVER, 2 POSITIONS	4941
S-4	SWITCH, WAFER, 7 POSITIONS	5419
S-5	SWITCH, DPDT (TEFLON)	254T
S-6	SWITCH, DPDT (TEFLON)	254T
S-7	SWITCH, DPDT (TEFLON)	254T
S-8	SWITCH, DPDT (TEFLON)	254T
T-1	NOT USED	
T-2	RF TRANSFORMER	T2/5072E
T-3	RF TRANSFORMER	T3/5072E
T-4	RF TRANSFORMER	T4/5072E
T-5	RF TRANSFORMER	T5/5072E
T-6	RF TRANSFORMER	T6/5072E
T-7	RF TRANSFORMER	T7/5072E
V-1	TUBE, 6J6	6J6
V-2	TUBE, 6V6	6V6
V-3	TUBE, 5718	5718
V-4	TUBE, 6BK7	6BK7
V-5	TUBE, 6E5	6E5
V-6	TUBE, 6AU6	6AU6
V-7	TUBE, 6AU6	6AU6
V-8	TUBE, 6BK7	6BK7
V-9	TUBE, 12AU7	12AU7
V-10	TUBE, 12AU7	12AU7
V-11	TUBE, 12AT7	12AT7
V-12	TUBE, 6BK7	6BK7
V-13	TUBE, 5718	5718
	ATTENUATOR (COMPLETE)	5415

7-2 PARTS LIST FOR POWER SUPPLY SECTION

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
C-200	2μF, 600V, BATHTUB	1748
*C-201 A-B	20/20μF, 475V, ELECTROLYTIC	6355-8
C-202	NOT USED	
C-203	1000μμF, CERAMIC (TUBULAR) 500V	6361-25
C-204	0.1μF, 400V, PAPER	6353-4
F-200	FUSE, 5 AMP, 250V	246
L-201	CHOKE (8 HENRY) C-1709	4723
NE-2	NEON LIGHT NE2	NE-2
P-200	AC LINE CORD	328
	(UNLESS OTHERWISE INDICATED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.)	
R-200	330 K, 1 WATT	3341-G
R-201	270 K, ½ WATT	2741-E
R-202	150 K, 1 WATT	1541-G
R-203	12 K, 2 WATT	1231-H
R-204	33, 1 WATT	3301-G
R-205	100, 1 WATT	1011-G
R-206	100, 1 WATT	1011-G
R-207	6.8 K, 1 WATT	6821-G
R-208	100, 1 WATT	1011-G
R-209	33, 1 WATT	3301-G
R-210	100, 1 WATT	1011-G
R-211	330 K, 1 WATT	3341-G
R-212	100 K, POT, VARIABLE	121
R-213	180 K	1841-E
S-200	SWITCH, SPST	255-C
T-200	TRANSFORMER, (POWER)	321
T-201	TRANSFORMER, (FILAMENT)	952
V-201	TUBE, 5Y3	5Y3
V-202	TUBE, 6AQ5	6AQ5
V-203	TUBE, 6AQ5	6AQ5
V-204	TUBE, 6AG5	6AG5
V-205	TUBE, 12AU7	12AU7
V-206	TUBE, OB2	OB2

*C-12 A-B AND C-201 A-B ARE COMBINED IN ONE UNIT.

CUSTOMER		PO NO DATE	
LIGNA SWEEP CP SERIAL NO			
BAND NO	CENTER FREQ	CRYSTAL FREQ NO	TO OPERATE AT
1			
2			
3			
4			
5			
6			

V1 SWP GEN 6J6

V2 SAWTOOTH AMPL 6V6

V3 OSC 5718

V13 OSC 5718

V4 30MC OSC 6BK7

V5 ZERO INDICATOR 6E5

V12 28 MC OSC 6BK7

V6 1ST AGC AMPL 6AU6

V7 2ND AGC AMPL 6AU6

V8 AGC CONTROL 6BK7

V9 1ST TRIGGER AMPL 12AU7

V10 2ND TRIGGER AMPL 12AU7

V11 PIP GEN 12AT7

V201 5Y3

V202 6AC5

V203 6AQ5

V204 6AG5

V205 12AU7

V206 0B2

SWEEP WIDTH

SWEEP CENTERING

NOTE
MARKER CIRCUIT LAYOUT DESIGNED TO CUSTOMER'S CRYSTAL REQUIREMENTS

NOTE
UNLESS INDICATED OTHERWISE
ALL RESISTANCES ARE IN OHMS
ALL CAPACITANCES ARE IN μμf
* FACTORY SELECTED
▲ FACTORY ADJUST

A.U.A. SERIAL NO 20116

Figure 7-1A, Ligna-Sweep Model CP Schematic, KD-5072-F.
A.U.A. Serial No. 20116

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PROCEDURES
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